

**(43) Date of A Publication 07.05.1997**

<p>(21) Application No <b>9521130.6</b></p> <p>(22) Date of Filing <b>16.10.1995</b></p>	<p>(51) INT CL<sup>6</sup> <b>B05B 1/18 , A47K 7/00 , B05B 1/16</b></p>
<p>(71) Applicant(s) <b>Akihiro Inahara</b> <b>188-9 Naka 1-Ban, Mihata-Cho, Nabari City,</b> <b>Mei 518-04, Japan</b></p>	<p>(52) UK CL (Edition O ) <b>B2F FGD F133 F305 F314 F315</b> <b>U1S S1713</b></p>
<p>(72) Inventor(s) <b>Akihiro Inahara</b></p>	<p>(56) Documents Cited <b>None</b></p>
<p>(74) Agent and/or Address for Service <b>Gill Jennings &amp; Every</b> <b>Broadgate House, 7 Eldon Street, LONDON,</b> <b>EC2M 7LH, United Kingdom</b></p>	<p>(58) Field of Search <b>UK CL (Edition O ) B2F FAB FJA FGD</b> <b>INT CL<sup>6</sup> A47K 7/00 , B05B 1/18</b> <b>Online database [WPI]</b></p>

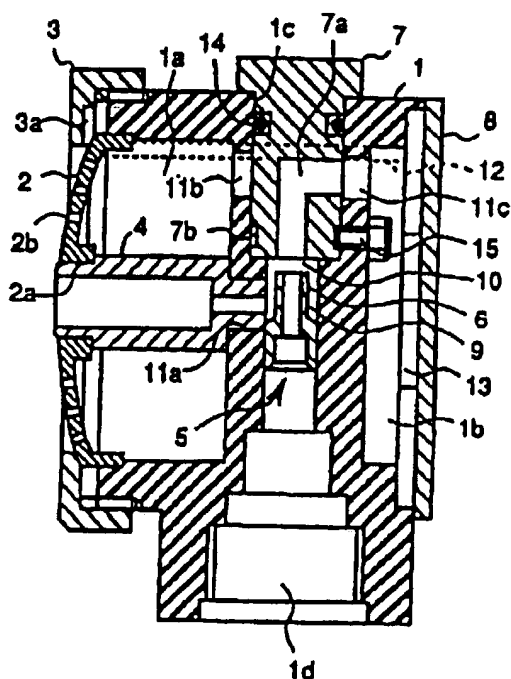
**(54) Shower head with suction cleaner**

(57) A shower head has a shower plate 2 and a suction tube 4. Valve 7 is rotatable about its longitudinal axis to give either a shower, by connecting water inlet 1d to aperture 11b, a suction mode, by connecting the inlet to drain outlet 11c, or a jet when the valve connects the inlet to neither of apertures 11b nor 11c.

Water entering through the inlet 1d passes via the venturi nozzle 6, which, in the illustrated position of valve 7, produces a reduction of pressure in the suction tube 4. In this mode, some water passes via passage 12 to space 3a and so gives a small flow down the outside of the shower plate to assist in suction cleaning of the skin etc.

When the valve connects the inlet to neither of apertures 11b nor 11c, the water is forced to leave the head by the suction tube 4, thus providing a jet.

**Figure 1B**



**GB 2306351 A**

SHOWER WITH A SUCTION TYPE CLEANER

The invention relates to a shower with a suction type cleaner which may be used to remove fat, waste matter, and waste of makeup and the like from the inside of the pore of the skin by the negative sucking force utilizing the running water used for a shower.

As a means to remove waste matter and the like stuck in the pore of the skin, in a suction type cleaner disclosed in Japanese Patent Publication No. 24677 of 1995, the cleaner is connected to a source of running water by means of a hose, negative pressure is generated by the running water so as to suck out the waste matter in the pore of the skin by the negative pressure by means of a suction cap in close contact with the skin. In the case where the waste matter is to be sucked out by the use of the sucking force of negative pressure caused by the running water in such manner as stated above, it is possible to use the cleaner safely and sanitarily in a toilet room or a bathroom where the face is usually washed without the danger of accidents such as being struck by electricity. As compared to an electrically operated suction apparatus, it is not only possible to manufacture an apparatus itself of simple construction at a low price but also possible to reduce the running cost. Furthermore, because the negative pressure is caused to be generated in the apparatus connected by means of a hose to a source of running water such as a faucet and the suction cap provided with this apparatus is caused to be in close contact with the skin, it is possible to cause the sucking force of negative pressure to act on the skin with excellent responsiveness.

However, in a conventional suction type cleaner of the above, in the case where the above cleaner is connected to a faucet by means of a hose, it can be used as a suction type cleaner only and therefore an exclusive faucet for the suction type cleaner becomes necessary. Especially, in the

case where a restriction is provided in a portion of a running water passage in order to generate negative pressure, because the water pressure in the hose which connects the faucet and the cleaner rises, causing the hose to come off easily from the faucet, the hose must be installed strongly to the faucet, making it impossible to remove the hose easily from the faucet. For example, in the case where only one faucet is available in a toilet room or a bathroom and the faucet has been fitted with a hose to which the suction type cleaner is connected, there will be no faucet available for water supply and there have been difficulties in usual face washing and bathing.

An object of the present invention is to provide a shower with a suction type cleaner which does not use a faucet exclusively for a facial treatment apparatus only and does not cause inconvenience to washing the face in a washing stand or bathing in a bathroom since the suction force of negative pressure is caused to be generated by utilizing the running water as opposed to a shower, as a result of taking notice of the fact that a shower is generally provided in a washing stand or a bathroom where a suction type cleaner is used. Another object of the present invention is to provide a shower with a suction type cleaner which is also capable of have massaging effect for the skin by making it possible to discharge the running water as a jet stream as opposed to a shower.

The invention provides a shower head with a water inlet portion to be connected to a source of running water by means of a hose, a negative pressure generating portion for generating negative pressure in a space by causing the running water flowing in from the water inlet portion to pass into a passage, a draining portion for draining the running water externally from one side, a showering portion for discharging the running water externally from a number of small holes, a selector valve for communicating the draining portion or the showering portion with the negative pressure generating portion and a sucking portion with one

end thereof being communicated with the space of the negative pressure generating portion and the other end thereof being opened externally from the other side thereof.

5       The invention described in claim 2 comprises the aforementioned selector valve which communicates the showering portion with the negative pressure generating portion and a passage which is formed to communicate the water inlet portion with the showering portion.

10       The invention described in claim 3 comprises a connecting pipe which communicates between the aforementioned draining portion and the open side of the aforementioned sucking portion.

15       The invention described in claim 4 comprises the aforementioned selector valve which communicates the draining portion with the negative pressure generating portion and a passage which is formed to freely change the flow rate of a portion of the water flowing out from the negative pressure generating portion in order to introduce  
20       water to the showering portion.

      The invention described in claim 5 comprises the small holes of the aforementioned showering portion which are formed on the open side of the aforementioned sucking portion.

25       The invention described in claim 6 comprises the aforementioned selector valve which is a 3-way selector valve for selectively communicating the water flowing into the aforementioned negative pressure generating portion either with the aforementioned draining portion, the  
30       aforementioned showering portion or the aforementioned sucking portion.

      In the invention when the draining portion is communicated with the negative pressure generating portion by the selector valve, the water flowing in from the water  
35       inlet portion is discharged externally from the draining portion through the negative pressure generating portion. And, negative pressure is generated in the negative

pressure generating portion by the running water and the outside air is sucked in from the sucking portion. On the other hand, when the showering portion is communicated with the negative pressure generating portion by the selector valve, the water flowing in from the water inlet portion is discharged from the small holes of the showering portion through the negative pressure generating portion. Therefore, by causing the sucking portion to contact the skin when the draining portion is communicated with the negative pressure generating portion, the waste matter and the like in the pore of the skin is sucked out, and it is possible to use this device as a suction type cleaner.

When the showering portion is communicated with the negative pressure generating portion, this device can be used as a shower.

In the invention described in claim 2, sufficient quantity of water-for washing face and the like is discharged as the quantity of the water flowing into the showering portion increases.

In the invention described in claim 3, in the case where the draining portion is communicated with the negative pressure generating portion by the selector valve, a portion of water having reached the draining portion is introduced to the open side of the sucking portion through the connecting pipe. Therefore, in the case where this device is used as a suction type cleaner, water is supplied to the skin with which the sucking portion comes into contact, suction by the sucking portion of the waste matter from the pore of the skin and movement of the sucking portion are performed smoothly.

In the invention described in claim 4, in the case where this device is used as a suction type cleaner, the quantity of water supply for the skin can be increased and decreased. Therefore, water can be supplied in the quantity according to a preference of the user.

In the invention described in claim 5, the side which faces the skin when this device is used as a suction type

cleaner and the side to which water is discharged when this device is used as a shower will be the same. Therefore, it is possible to use this device as the suction type cleaner or as the shower by simply operating the selector valve  
5 without shifting this device from one hand to the other.

In the invention described in claim 6, the water flowing into the negative pressure generating portion is introduced selectively either to the draining portion, showering portion or sucking portion by the operation of  
10 the selector valve. When the passage of the water flowed in the negative pressure generating portion is communicated with the sucking portion, the water is discharged externally from the sucking portion as a jet stream, and therefore, it is possible to use this device as a jet  
15 stream type massage apparatus.

In the accompanying drawings:-

Figs. 1A, 1B and 1C are a plan view, a sectional side view, and a rear view, respectively, of a shower with a suction type cleaner which is an embodiment of the  
20 invention; and,

Figs. 2A, 2B and 2C are similar views of a second embodiment.

As shown in Fig. 1, a body 1 is formed from resin and has concave portions 1a through 1d respectively being open  
25 in the front, back, top and bottom. A concave portion 1a of the front of the body 1 is covered by a shower plate 2. The shower plate 2 is processed by pressing a stainless steel plate, for example. At the centre of the shower plate 2 is formed a hole portion 2a and a number of small holes 2b is  
30 formed around the hole portion 2a. The shower plate 2 is installed on the concave portion 1a by means of an installation member 3. The installation member 3 is screwed to the front of the body 1 so as to press the edge portion of the shower plate 2 against the peripheral portion of the  
35 concave portion 1a over the entire circumference thereof. In the installation member 3, a step 3a is formed in a portion of the peripheral portion opposing the shower plate

2. The peripheral portion of the installation member 3 does not contact the surface of the shower plate 2 in this step 3a. In the hole portion 2a of the shower plate 2 is fitted one end of a suction pipe 4 installed in the concave portion 1a to be exposed on the front side of the body 1.

At almost the centre inside, the body 1 is formed with a negative pressure generating portion 5. The negative pressure generating portion 5 is communicated with the concave portion 1c and the concave portion 1d being opened in the top and the bottom of the body 1. The centre axis of the negative pressure generating portion 5 is positioned on the same axis as the respective centre axes of the concave portion 1c and the concave portion 1d. In the negative pressure generating portion 5 is inserted a nozzle 6. The inside diameter of the negative pressure generating portion 5 is made to be smaller than the inside diameter of the concave portion 1d, and the inside diameter of the nozzle 6 is made to be further smaller than the inside diameter of the negative pressure generating portion 5. In the concave portion 1d is to be installed one end of a hose not shown in the drawing. The other end of the hose is installed at a source of running water such as a faucet of the city water. In the concave portion 1c is installed a selector valve 7. The concave portion 1b is covered by a cover 8. The cover 8 is fixed on the back of the body 1 by the screw which is not shown in the drawing.

The concave portion 1a of the front is communicated with the negative pressure generating portion 5 at a connecting hole 11a. The concave portion 1a is communicated with the concave portion 1c on the top by means of a connecting hole 11b. The concave portion 1b of the back is communicated with the concave portion 1c by means of a connecting hole 11c. The concave portion 1b is communicated with the step 3a of the installation member 3 by means of a plurality of connecting hole 12. In the connecting hole 11a is fitted the other end of the suction pipe 4. Between the inner circumferential surface of the negative pressure

generating portion 5 and the outer circumferential surface of the nozzle 6 is provided a gap 9. The other end of the suction pipe 4 is communicated with this gap 9. In the concave portion 1b at the back, an opening 13 is formed at  
 5 3 positions of the peripheral portion and the concave portion 1b is opened to the side by means of this opening 13.

In the inside of the selector valve 7 is formed a connecting hole 7a. The connecting hole 7a opposes the  
 10 nozzle 6 at one end and opposes the connecting hole 11b or 11c at the other end. The selector valve 7 is inserted into the concave portion 1c by means of a packing 14 and is freely rotatable in the concave portion 1c round the centre in longitudinal direction as the axis of rotation. By  
 15 rotating the selector valve 7, the other end of the connecting hole 7a is selectively connected to the connecting hole 11b or to the connecting hole 11c. On the circumferential surface of the selector valve 7 is formed a step portion 7b in the circumferential direction. In the  
 20 step portion 7b is fitted the tip of a set screw 15 from the concave portion 1b. Between the selector valve 7 and the nozzle 6 is provided a gap 10. The front view of FIG. 1 (A) illustrates the condition in which the installation member 3 is removed and only a part of small holes 2b of a  
 25 plurality of small holes 2b is shown. The rear view of the same drawing (C) shows the condition in which the cover 8 is removed.

According to the construction described above, in the inside of the body 1 is formed, by rotating the selector  
 30 valve 7, a first waterway which leads to the concave portion 1b from the concave portion 1d to be connected to a source of running water by means of a hose not shown in the drawing through the nozzle 6, the connecting hole 7a and the connecting hole 11c of the selector valve 7 or a  
 35 second waterway which leads to the concave portion 1a from the concave portion 1d through the nozzle 6, the connecting hole 7a and the connecting hole 11b. When the selector



valve 7 is rotated to a position where the connecting hole 7a does not oppose either of the connecting hole 11b or the connecting hole 11c, there is formed a third waterway which leads to the inside of the suction pipe 4 from the concave portion 1d through the nozzle 6, the gap 10 and the gap 9. When the faucet of the waterway which is the source of running water connected to the concave portion 1d is opened, the running water flowing into the body 1 is restricted by the nozzle 6 and flows into the connecting hole 7a of the selector valve 7 at an increased flow velocity. At this time, static pressure on the flowing surface of the running water is reduced with an increase in the flow velocity and is turned into negative pressure with respect to the atmospheric pressure. The negative pressure on the surface of the running water is transferred to the inside of a nozzle 4 through the gap 10 and the gap 9.

As shown in FIG.1 (B), in the case where the first waterway of the above is formed in the body 1, the running water flowing into the connecting hole 7a from the nozzle 6 is introduced to the concave portion 1b of the back through the connecting hole 11c. The running water introduced to the concave portion 1b is discharged externally from the opening 13, a part of the discharged running water is introduced to the step portion 3a of the installation member 3 through the connecting hole 12, and is exposed on the surface of the shower plate 2. Therefore, in the case where the first waterway is formed in the body 1 and the suction pipe 4 exposed from the centre of the shower plate 2 is caused to contact the skin, the skin is sucked by the negative pressure generated in the gap 10 by the running water, so that the waste matter in the pores of the skin is discharged externally from the opening 13 of the concave portion 1b through the inside of the suction pipe 4, the gap 9, the gap 10, and the connecting hole 7a. Appropriate moisture is given to the skin by the water which is introduced to the step portion 3a of the installation member 3 through the connecting hole 12 and

exposed on the surface of the shower plate 2, so that suction of the waste matter in the pore of the skin and sliding of the suction pipe with respect to the skin are performed smoothly.

5           In the case where the selector valve 7 is rotated 180° from the condition shown in FIG. 1(B) and the second waterway of the above is formed in the body 1, the running water flowing into the connecting hole 7a from the nozzle 6 is introduced to the concave portion 1a of the front  
10 through the connecting hole 11b. The running water introduced to the concave portion 1a is discharged to the outside of the front side from the small hole 2b of the shower plate 2. Therefore, in the case where the second waterway of the above is formed in the body 1, it is  
15 possible to use the body 1 as a shower apparatus. At this time, because the exposed surface of the suction pipe 4 and the installation surface of the shower plate 2 correspond, it is possible to change mutually the suction of the waste matter in the pore of the skin and the face washing by the  
20 shower without shifting the body 1 from one hand to the other.

          In the case where the selector valve 7 is rotated 90°, for example, from the condition shown in FIG. 1(B) and the third waterway of the above is formed in the body 1, the  
25 running water flowed out from the nozzle 6 is discharged as the jet stream to the outside of the front side through the gap 10, the gap 9, and the inside of the suction pipe 4. Therefore, in the case where the third waterway of the above is formed in the body 1, it is possible to use the  
30 body 1 as a jet stream type massage apparatus by applying to the skin the water discharged from the suction pipe 4.

          FIG. 2 illustrates a plan view, a sectional side view, and a rear view of a suction type cleaner with a shower according to an embodiment of the invention described in  
35 claims 5 and 6. A body 21 is formed from resin into a shape for easy holding. A concave portion 21a of the front of the body 21 is covered by a shower plate 22 formed with a

number of small holes 22b. In a hole portion 22a at the centre of the shower plate 2, a suction pipe 24 is fitted in from outside and screwed to a threaded portion formed on the outer circumferential surface of a connecting hole 31a.

5 The shower plate 22 is pressed by a step portion 24a of the suction pipe 24 screwed to the threaded portion of the connecting hole 31a and fixed to the concave portion 21a. A concave portion 21b of the back side of the body 21 is covered by a cover 28. The cover 28 is fixed to the back of

10 the body 21 by means of a set screw 28 of the cover 28. In a concave portion 21c of the top of the body 21 is inserted a selector valve 27 freely rotatably round the centre in longitudinal direction as an axis. A concave portion 21d of the bottom of the body 21 is connected to a source of

15 running water such as the faucet of city water by means of a hose which is not shown in the drawing.

The concave portion 21a of the front is communicated with the concave portion 21c of the top by means of a connecting hole 31b and a sub-connecting hole 42 and the

20 concave portion 21b of the back is communicated with the concave portion 21c of the top by means of a connecting hole 31c. The suction pipe 24 is communicated with a gap 29 between a negative pressure generating portion 25 and a nozzle 26 by means of the connecting hole 31a. The concave

25 portion 21d of the bottom is communicated with the concave portion 21c of the top by means of a bypass hole 41. In the selector valve 27 is formed connecting holes 27a through 27c. The connecting hole 27b is communicated with one end of the connecting hole 27a and one end of the connecting

30 hole 27c and opened to the circumferential surface of the selector valve 27. The other end of the connecting hole 27a opposes the nozzle 26 and the other end of the concave portion 21c is opened to the circumferential surface and the bottom of the selector valve 27.

35 According to the construction of the above, in the case where the connecting hole 27b of the selector valve 27 is communicated with a connecting hole 31c, the running

water flowed into the body 21 from the concave portion 21d is introduced to the concave portion 21b through the nozzle 26, the connecting hole 27a, the connecting hole 27b, and the connecting hole 31c, and discharged to the outside from an opening, not shown in the drawing, formed in the concave portion 21b. At this time, negative pressure is generated in the gap 29 with an increase in the flow velocity of the running water discharged from the nozzle 26. This negative pressure is transferred to the inside of the suction pipe 24 by means of the connecting hole 31a. Part of the running water flowed into the connecting hole 27a from the nozzle 26 is introduced to the concave portion 21a through the connecting hole 27c and the subconnecting hole 42 and exposed on the surface from a small hole 22b of the shower plate 22. The quantity of the water introduced to the concave portion 21a through a connecting path 27b and a sub-connecting path 42 is increases and decreases by the opposing area of the connecting path 27b and the sub-connecting path 42 and the opposing area of the connecting path 27b and a connecting path 31c, but the opposing areas between these connecting paths is changed by the rotating angle of the selector valve 27. Therefore, by properly operating the rotating angle of the selector valve 27, it is possible to increase or decrease the amount of water supply to the skin according to a preference of the user when the suction pipe 24 is caused to contact the skin in order to suck out waste matter in the pore of the skin.

In the case where the selector valve 27 is rotated 180° from the condition shown in FIG. 2(B) and the connecting hole 27b is communicated with the connecting hole 31b, the running water flowing into the body 21 from the connecting hole 21d is introduced to the connecting hole 21a through the nozzle 26, the connecting hole 27a, the connecting hole 27b and the connecting hole 31b and discharged to the outside of the front side from the small hole 22b of the shower plate 22. At this time, the connecting hole 27c formed in the selector valve 27 opposes

the bypass hole 41 formed in the body 21. As a result, the running water flowing into the concave portion 21d is introduced to the connecting hole 27b not only through the nozzle 6 but also through the bypass hole 41 and the connecting hole 27c. Therefore, it is possible to introduce a large quantity of running water to the concave portion 21a and to discharge from a small hole 21b of the shower plate 22 a sufficient quantity of water to be used for washing face and the like.

In the case where the connecting hole 27b does not oppose either of the connecting hole 31b or the connecting hole 31c as in the case where the selector valve 27 is rotated 90°, for example, from the condition shown in FIG. 2(B), the running water flowed into the body 21 from the concave portion 21d is introduced to the inside of the suction pipe 24 through the nozzle 26, the gap 29 and the connecting hole 31a. Therefore, by sprinkling to the skin the jet stream discharged from the suction pipe 24, it is possible to use the body 21 as a jet stream type massage apparatus.

Besides, by indicating the amount of water which increases and decreases by the opposing area of the connecting path 27b and the sub-connecting path 42 and the opposing area of the connecting path 27b and the connecting path 31c on the top of a fixing member 43 for maintaining the inserting conditions in the concave portion 21c of the selector valve 27, it is possible to easily set the amount of supply water when sucking the waste matter in the pore of the skin by the rotating of the selector valve 27.

According to the invention, it is possible to suck out the waste matter in the pore of the skin and to use this device as a suction type cleaner by causing the sucking portion to contact the skin when the draining portion is communicated with the negative pressure generating portion, and when the showering portion is communicated with the negative pressure generating portion, it is possible to use this device as a shower and to use the flow of water as a

shower, so that the faucet will not be used exclusively for a facial treatment apparatus only and there will be no inconvenience caused to washing the face in a washing stand or bathing in a bathroom.

5       According to the invention described in claim 2, in the case where this device is used as a shower, it is possible to discharge the quantity of water sufficient for washing the face and the like.

10       According to the invention described-in claim 3, in the case where this device is used as a suction type cleaner, it is possible to supply water to the skin with which the sucking portion contacts, and suction by the sucking portion of the waste matter and the like from the pore of the skin and movement of sucking portion can be  
15       performed smoothly.

      According to the invention described in claim 4, in the case where this device is used as a suction type cleaner, it is possible to supply the quantity of water according to a preference of the user.

20       According to the invention described in claim 5, it is possible to use this device simply by operating the selector valve to mutually change the suction type cleaner or the shower without shifting the device from one hand to the other, thereby improving the operating performance.

25       According to the invention described in claim 6, it is possible to use this device not only as a shower and a suction type cleaner but also as a jet stream type massage apparatus.

CLAIMS

1. A shower with a suction type cleaner, which comprises a water inlet portion to be connected to a source of running water by means of a hose, a negative pressure generating portion for generating negative pressure in a space by causing the running water flowing in from the water inlet portion to pass through a passage, a draining portion for draining the running water externally, a showering portion for discharging the running water externally through a number of small holes, a selector valve for selectively communicating either the draining portion or the showering portion with the negative pressure generating portion, and a sucking portion with one end thereof being communicated with the space and the other end thereof being opened externally from one side thereof.

2. A shower with a suction type cleaner according to claim 1, wherein the selector valve communicates the showering portion with the negative pressure generating portion and a passage is formed for communicating the water inlet portion with the showering portion.

3. A shower with a suction type cleaner according to claim 1 or 2, wherein a connecting pipe is provided for communication between the draining portion and the side to which the sucking portion is opened, so that a portion of the water flowing into the draining portion is led to that side.

4. A shower with a suction type cleaner according to claim 1 or 2, wherein the selector valve communicates the draining portion with the negative pressure generating portion and a passage is formed to change freely the flow rate of a portion of the water flowing out from the negative pressure generating portion so as to introduce the water to the showering portion.

5. A shower with a suction type cleaner according to any one of the preceding claims, wherein small holes of the showering portion are formed on the open side of the sucking portion.

5

6. A shower with a suction type cleaner according to any one of the preceding claims, wherein the selector valve is a 3-way selector valve which selectively communicates the water flowing into the negative pressure generating portion either with the draining portion, the showering portion or the sucking portion.

10

7. A shower head, substantially as described with reference to the accompanying drawings.

15



16

**Patents Act 1977**  
**Examiner's report to the Comptroller under Section 17**  
**(The Search report)**

Application number  
 GB 9521130.6

**Relevant Technical Fields**

- (i) UK Cl (Ed.N)      B2F (FAB FJA FKD)  
 (ii) Int Cl (Ed.6)    A47K 7/00, B05B 1/18

Search Examiner  
 J H WARREN

Date of completion of Search  
 2 JANUARY 1996

**Databases (see below)**

(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii) ONLINE DATABASE (WPI)

Documents considered relevant following a search in respect of Claims :-  
 1-7

**Categories of documents**

- |  |   |
|--|---|
| <p><b>X:</b> Document indicating lack of novelty or of inventive step.</p> <p><b>Y:</b> Document indicating lack of inventive step if combined with one or more other documents of the same category.</p> <p><b>A:</b> Document indicating technological background and/or state of the art.</p> | <p><b>P:</b> Document published on or after the declared priority date but before the filing date of the present application.</p> <p><b>E:</b> Patent document published on or after, but with priority date earlier than, the filing date of the present application.</p> <p><b>&amp;:</b> Member of the same patent family; corresponding document.</p> |
|--|---|

Category	Identity of document and relevant passages	Relevant to claim(s)
	NONE	

**Databases:** The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).

Figure 1A

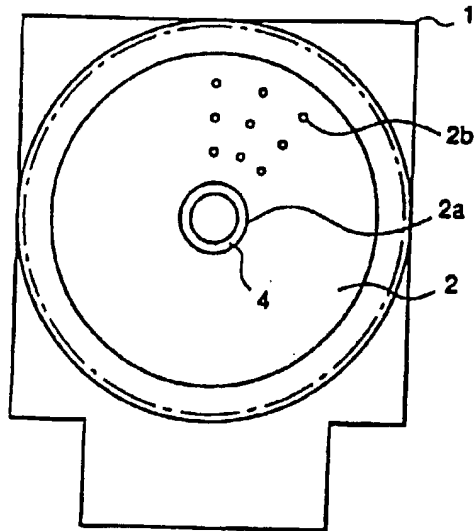


Figure 1B

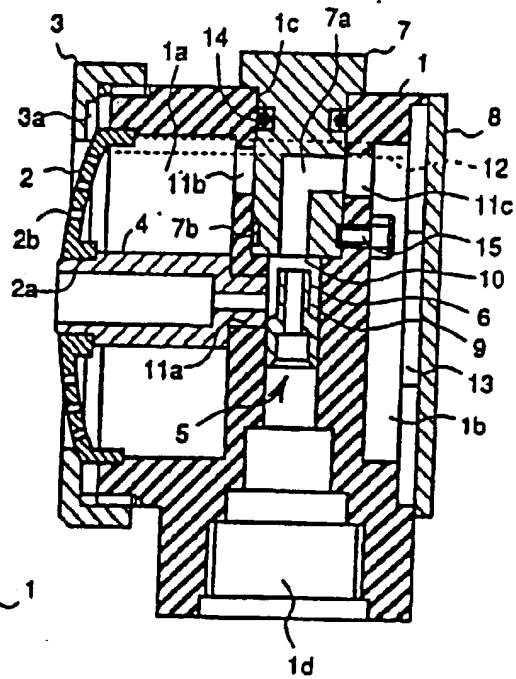


Figure 1C

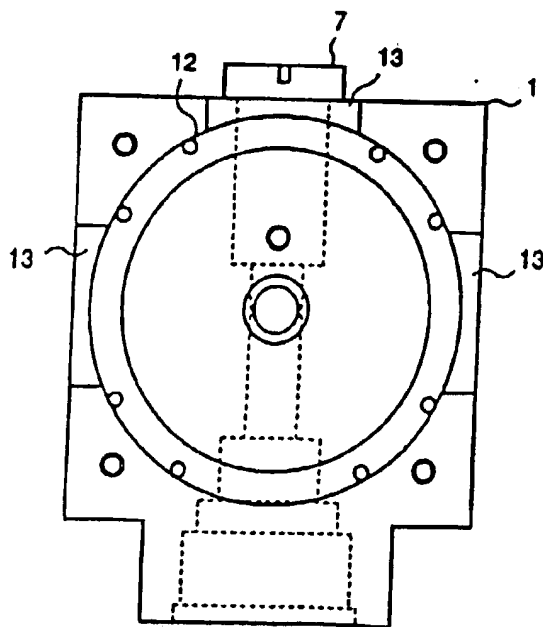


Figure 2A

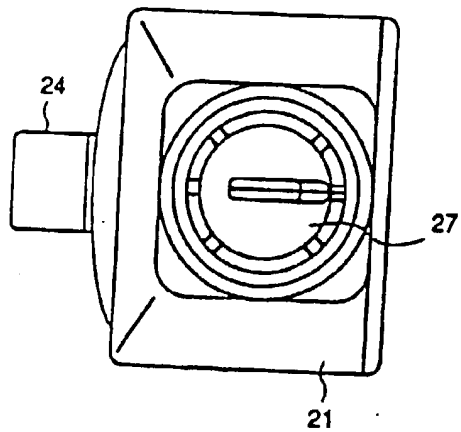


Figure 2B

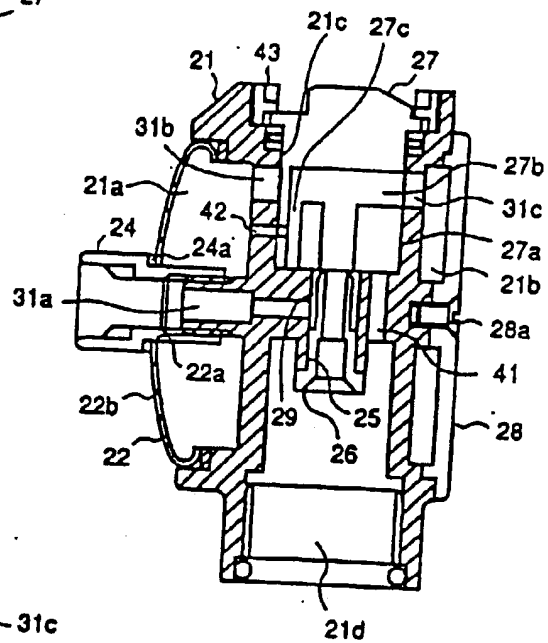


Figure 2C

